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12 January 1978

TRANSLATIONS ON EASTERN EUROPE

SCIENTIFIC AFFAIRS

No. 569

EAST

EUROPE

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No. 569

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CONTENTS (Continued)

BRIEFS

EARTHQUAKE IN KUKES--According to information from the Seismological Center, a earthquake registering 3.0 on the Richter scale was registered in the vicinity of Kukes on 25 December. It was announced that there were no injuries and there was no material damage. [Text] [Tirana BASHKIMI in Albanian 27 Dec 77 p 1]

EARTHQUAKE IN GJIROKASTER--According to information from the Seismological Center there was an earthquake registering 4 on the Richter scale, on 5 December, in the evening, in the areas of Golem, Kardhiq, and Picar in Gjirokaster District. The earthquake registered 4 in Gjirokaster City, 5 in the villages of Golem, Kardhiq, and Picar, and it was less intense in the area of Polican and Lower Dropulli. There were no injuries and there was no material damage. [Text] [Tirana ZERI I POPULLIT in Albanian 7 Dec 77 p 1]

CSO: 2102

QUALITIES OF NEW ES-5003 COMPUTER MEMORY TAPE DESCRIBED

Sofia TEKHNICHESKO DELO in Bulgarian 19 Nov 77 p 5

[Article by Engineer Mira Radeva: "The Electronic Memory -- Memory of the Future"]

> [Text] Bulgaria is a worthy partner in the production of magnetic-tape peripherals. A prototype fights to make its name. The main purpose is optimal technical decisions. Will the Storage Device Plant in Plovdiv keep its promise?
>
> Not long ago the concept "electronic computer" evoked admiration for this creation of the human mind. Now, without losing its prestige or significance, it has already become a necessity for our daily existence. We have become used to it. More and more frequently people have begun to "depend" on computer equipment, to rely on its error-free memory and on its unparalleled and precise assessment, to respect its uncompromising character. And not only that, they have begun to trust it. Why not? If large computer complexes today compute with absolute accuracy and minimal time loss the results of the "Universiad-77" competition, participate in planning the national economy, successfully control traffic at busy intersections, then tomorrow . . . tomorrow they will help physicians diagnose even the most complex human diseases.

But that is the future. How near it is to our own time cannot be asserted with certainty even by the specialists of the Computer Technology Institute in Sofia. More important is something else: that they are absolutely certain of it and are putting all their creative powers and capabilities into speeding it up, into bringing it more rapidly to our times.

For the nonspecialists in electronic engineering it is a bit difficult to grasp and understand the content of their complex scientific projects. For example, while some of the visitors to the Computer Technology Palace at the 33d Plovdiv Fair passed over one of the exhibits with indifference,

for specialists the ES-5003 magnetic-tape storage device, designed at the Computer Technology Institute, aroused entirely warranted interest. This complex device, which is the external or peripheral store for large computers, combines in itself units and components from different fields of technology. Involved here are pure electronics, computer technology, mathematics and mathematical logic, electromechanics and pneumatics.

"How did you achieve the optimum combination of input and output characteristics of the various components that enabled you to integrate them successfully in the storage device?" I asked physicist Khristo Momerin, head of the Tape-Unit Electronics Section. Actually, he is only one of the more than 100 persons on the team that invented the development.

"It wasn't easy to effect this coordination in the operation of the different components in it. But we devoted a lot of work and wished a lot and . . . above all we put our hearts into the work!"

A person somehow naturally pictures these four years as years of strenuous and persistent work, of successes and, of course, failures. These always accompany creative quests and are an inseparable part of the effort to secure something new. And then, finally, the "something new" is finished. The completed prototype of the magnetic-tape storage device, designed for the purposes of computer technology, won the highest distinction on its first official introduction to consumers -- a gold medal at the Plovdiv International Fair. This is also recognition for Bulgaria's electronic industry, specializing in the production of magnetic-tape and disk peripherals within the CEMA framework. The value of this recognition is even higher because this development is on the most modern world level. And it is completely Bulgarian! The elements used in its design are produced in Bulgaria or in CEMA-member countries.

I continue with my questions for Khristo Momerin, Senior Science Associate and Candidate of Technical Sciences Engineer Todor Popov, and Engineer Vladimir Chervenakov. "What distinguishes this development from previous storage-device designs, what is new and advanced about it, and what does it 'promise' for the future?"

The answers are clear and categorical.

"An up-to-date and rational solution of the tape track in the device. The magnetic tape is loaded automatically and the operator is shut off from any access to it. This prevents its possible contamination, which can happen from being touched just once by hand. This in turn might lead to unwanted results -- an error in the information, a loss of time in order to regenerate it. By introducing a cartridge (protective belt), the tape is protected against dust, moisture and the influence of the atmosphere.

"In the old designs of the ES-5012 device it is impossible in principle for a cartridge to be used.

"The magnetic tape moves on air cushions. All contact with external objects and parts of the tape-actuating mechanism is avoided. The tape touches only the magnetic head, where the recording is made and the information is reproduced. This results in preservation of the magnetic tape. It can travel past the head 100,000 times without being damaged, whereas in the previous devices the tape stood up under a maximum of 50,000 passes.

"The tape speed is 5 meters per second and is two and a half times as great as the speed at which the ES-5012 operates, which means accordingly that there will be a two and a half-fold increase in the machine's productivity.

"In principle, two types of NRZ-1 recording are used, as well as phase coding. Thereby the information recorded on the tape is doubled because the operation takes place with double density. The overall effect for the computer is that its efficiency is doubled again.

"There is also a significant increase in the magnetic-tape rewind speed -- about 20 m/sec. Considering that in the old developments this speed was about 6 m/sec, you can figure out how much operator time is saved and how much of the machine's so-called 'dead time,' due to the rewinding of the magnetic tape, is closed up."

One more very important question has been solved by the designers of the device. The diagnosis and elimination of possible damage to any of its components has been made much easier. This is effected through the multiplex interface and by the transmission of so-called state bytes.

"Surely this new, modern magnetic-tape storage device is very expensive?" is the question which arises automatically as a result of the enumerated qualities and advantages of the prototype.

"Not at all!" is the almost joint reply of the specialists, the inventors of this development. "Its cost isn't much different from that of the old devices!"

And the reason for this is quite clear and convincing. In designing it, optimum solutions involving raw and other materials, consistent with the existing production techniques of the plants producing the individual components, were sought and adopted. And the designers themselves are people with a truly enviable soaring of creative and technical thought, with professional routine and solid practical training. There could be no other explanation for the interesting and modern treatment of the device's driving motor, which is a d-c electric motor with a hollow rotor, built-in optical tachometer and coupled vacuum drive roller. In less than a quarter revolution it reaches its rated speed of 2400 rpm. Or the new vacuum pump, compressor, the ceramic conductors, the air filter . . .

It must not be forgotten that the design of the magnetic-tape storage device is basic and will still undergo many modifications in the future. Work is already under way on some of these at the institute.

It remains only to be desired that the Storage Device Plant in Plovdiv will produce the promised series of magnetic-tape storage devices before the end of the year and will take inspiration from the hard and extraordinarily fruitful work over several years' time by the specialists of the Computer Technology Institute in Sofia.

6474
CSO: 2202

NEW COMPUTER STORAGE DEVICE DESCRIBED

Sofia OTECHESTVEN FRONT in Bulgarian 29 Nov 77 p 1

[Bulgarian Telegraph Agency story]

[Text] Within the CEMA framework our country specializes in the production of magnetic-tape and disk peripherals. One of the latest achievements in this area is the ES-5003 magnetic-tape storage device, the work of a team of inventors from the Computer Technology Institute.

The storage device includes a number of innovations, the chief purpose of which is to increase the machine's efficiency. Automatic loading and the protective belt of the tape safeguard it against any kind of contamination and double its life -- it can travel past the magnetic head 100,000 times without being damaged.

The other innovations also increase the machine's efficiency. The tape speed is two and a half times greater than in the previous model, and twice as much information can be recorded on the same tape. This increases efficiency over fourfold.

There is over a threefold increase in the tape rewind speed, thereby saving much of the machine's unproductive time. All components and parts for it are produced in Bulgaria or in some of the other CEMA-member nations. The Plovdiv Storage Device Plant is to start up production of the new product before the end of the year.

6474
CSO: 2202

SEMICONDUCTOR DESIGNATION SYSTEMS DESCRIBED

Sofia RADIO, TELEVIZIYA, ELEKTRONIKA in Bulgarian No 9, 1977 pp 23-26

[Article by Engineer B. Banchev and Engineer D. Savov, Plovdiv: "Designation of Semiconductor Devices"]

[Text] The rapid development of the semiconductor industry in various countries and the appearance of a large number of the most diverse types of semiconductor device are the reason for the creation of new and improved systems for their designation. Some of the older systems have undergone corrections taking into account the general trend in the development of semiconductor production, and some have gradually disappeared.

Bulgarian Semiconductor Devices

Digital and literal designations and a color code are used for labeling Bulgarian-made semiconductor devices. The basic technical requirement is that devices meet Bulgarian State Standard 9840-72, standardization documents for the individual type, and be manufactured according to the producer's specifications approved in accordance with the appropriate procedure.

In conformity with specifications, the following data are placed legibly and with an indelible mark on every semiconductor device: name or symbol of the producer; type of device; month and last two digits of year of manufacture; polarity sign (for diodes); other data (specifications according to standardization documents).

In conformity with the Bulgarian State Standard it is permissible to mark the type of diode, the gain factor of transistors and other data with a color code. This is possible when the standardization document for the individual type of semiconductor device indicates the color code and its decoding.

The designations of Bulgarian semiconductor devices have borrowed the features of some of the most prevalent designation systems. Combined letter-digit coding is used:

first element -- letter (digit) -- shows the kind of material: G(1), germanium; K(2), silicon;

second element -- letter -- the kind of device: D, diode; T, transistor;

third element -- number -- serial number of the device;

fourth element -- letter -- the gain subgroup to which the device belongs.

Gain subgroup can also be marked with a color code on the case of the transistors. The letters and color code are decoded with the help of the relevant standardization document for the particular device.

For example: GT7-312 -- blue dot -- germanium transistor, power, low-frequency, gain 54÷80 units;

2T6551A -- transistor, silicon, medium-power, serial No. 6551, gain 26÷55 units.

The need is keenly felt in Bulgarian technical literature for competent manuals with sufficient data about Bulgarian-made semiconductor devices.

Soviet Semiconductor Devices

Soviet semiconductor devices are designated in conformity with the following: devices made before 1963 according to State Standard 5461-59 (for example P403); devices made after 1963 according to State Standard 10862-64 (for example GT308); and after 1973 according to State Standard 10862-74

The designation of semiconductor devices according to State Standard 5461-59 consists of two or three elements.

First element: D, diodes; P(MP), transistors.

Second element: a number which characterizes the purpose of the device.

For diodes:

point-contact germanium	1÷100;
point-contact silicon	101÷200;
junction silicon	201÷300;
junction germanium	301÷400;
mixer microwave	401÷500;
multiplier	501÷600;
video detector	601÷700;
parametric germanium	701÷749;
parametric silicon	750÷800;
stabilitrons	801÷900;

varicaps	901÷950;
tunnel diodes	951÷1000;
rectifier columns	1001÷1100.

For transistors:

low-power germanium low-frequency	1÷100;
low-power silicon low-frequency	101÷200;
power germanium low-frequency	201÷300;
power silicon low-frequency	301÷400;
low-power germanium high-frequency	401÷500;
low-power silicon high-frequency	501÷600;
power germanium high-frequency	601÷700;
power silicon high-frequency	701÷800.

Third element -- a letter showing the modification of the device. In the absence of a modification no letter is placed.

Example of designation:

P15A transistor, low-power, germanium, low-frequency, modification A;

P701 transistor, power, silicon, high-frequency.

The designation of semiconductor devices according to State Standard 10862-64 is done with four elements.

First element -- a letter or digit indicating the semiconductor material:

G(1) germanium;

K(2) silicon;

A(3) gallium arsenide.

The designation beginning with the letter G is for germanium semiconductor devices operating at a temperature below +60° C.

The designation beginning with the letter K is for silicon semiconductor devices operating at temperatures below +85° C.

Designations beginning with the digits 1, 2 or 3 are intended for semiconductor devices operating at higher temperatures:

germanium up to +70° C;

silicon up to +125° C.

Second element -- a letter designating the type of device. For example: D, diodes; T, transistors; V, varicaps; A, microwave diodes; F, photodevices; N, uncontrolled multilayer switching devices (dynistors); U,

controlled multilayer switching devices (thyristors); I, tunnel diodes; S, stabilitrons; Ts, rectifier columns and units.

Third element -- a number designating the purpose or electrical properties of the semiconductor device:

transistors, low-power (T)

for low frequencies	101÷199;
for medium frequencies	201÷299;
for high frequencies	301÷399;

transistors, medium power (T)

for low frequencies	401÷499;
for medium frequencies	501÷599;
for high-frequencies	600÷699;

power transistors (T)

for low frequencies	701÷799;
for medium frequencies	801÷899;
for high frequencies	910÷999;

diodes (D)

rectifier, low-power	101÷199;
rectifier, medium-power	201÷299;
rectifier, power	301÷399;
general-purpose	401÷499;
pulse	501÷999;

varicaps (V)

tunable	101÷199;
multiplier	201÷299;

microwave diodes (A)

mixer	101÷199;
detector	201÷299;
modulator	301÷399;
parametric	401÷499;
switching	501÷599;

photodevices (F)

diodes	101÷199;
transistors	201÷299 etc.

Fourth element -- a letter designating the division of the technological type of groups.

For example:

GT105A: germanium transistor, low-power, low-frequency of group A, operating at temperature up to +60° C.

2T105A: silicon transistor, low-power, low-frequency of group A, operating at temperature up to +120° C.

The designations of selenium rectifiers consist of letters and digits. For example, AVS-15-60. The letters designate aluminum rectifier, selenium, and as for the digits:

the first group gives the length of the side of the square washer or the diameter in mm;

the second group gives the number corresponding to this rectifier.

For low-power rectifiers a designation is used in which the average value of the rectified current (mA) and the supplied variable voltage (V) are placed after the letters. For example: AVS-6-270M. The letter M signifies miniature.

Czechoslovak Semiconductor Devices

The designation according to standard NT-K003 consists of three consecutive groups -- digits, letters and digits. The type of device is given by the middle (literal) group. The first group of digits indicates the serial number of the type of device. The second group of letters signifies:

NN point-contact diode
NP junction-type detector diode;
NQ point-contact diode for high frequencies;
NT point-contact transistor;
NU junction-type transistor;
NV special-purpose transistor;
PN photoresistance;
PP photocell.

The third group of the designation consists of digits. Digits from 40 to 99 designate the fabrication material and are arranged in the following code:

40÷49 glass;
50÷59 ceramics;

60÷69 synthetic material;
70÷79 metal;
80÷99 special version.

The design version of transistors and photocells is indicated by the last number of the third group of digits according to the following code:

0 case ∅ 5 mm and h = 13 mm, with filament semiconductor leads along the axis of the case;

1 case ∅ 10 mm and h = 50 mm, with filament semiconductor leads from one side of the case;

2 body of pearl with carrier semiconductor (minus case);

3 case in shape of tablet with radial leads;

4 rolled body with ∅ 6 mm and h = 28 mm with ribbon leads.

The designation according to standard NR-K026 consists of two parts. The literal part is constructed of two letters. The first letter characterizes the semiconductor used -- germanium or silicon.

The second letter designates the type of semiconductor device:

A diode;

C low-frequency transistor;

D low-frequency power transistor;

E tunnel diode;

F high-frequency transistor;

L high-frequency power transistor;

P photodiode and phototransistor;

S switching transistor;

U power switching transistor;

T controlled semiconductor gate (thyristor);

Y semiconductor gate;

Z stabilitron (Zener diode).

The group of digits which is in second place consists of three digits. It serves as a serial number to differentiate individual semiconductor devices and has no special significance. For example, GF-505: germanium high-frequency transistor with serial number 505.

The principal systems of designation for foreign semiconductor devices are the following:

JEDEC System

The most prevalent is the marking system adopted by JEDEC [Joint Electron Device Engineering Council] of the United States. According to this system, semiconductor devices are designated by an index in which the first digit shows the number of PN junctions:

1 diode

2 transistor etc.

After the index comes the letter N and then the serial number under which the device is registered by the EIA [Electronic Industries Association].

For example:

2N911 This is the 911th registered transistor;

1N777 This is the 777th registered diode etc.

One or more letters can be added to the index. Literal symbols serve to designate interchangeable devices.

It is important to realize that semiconductor devices whose serial numbers come one after the other may differ considerably in their characteristics and socket.

The EIA registers devices according to the characteristics submitted by the producer. That is to say that any producer whose devices are similar in characteristics and parameters to semiconductor devices registered prior thereto by EIA has a right to produce and deal in the designations accepted by JEDEC.

In conformity with American military specification, the prefix JAN is added to the industrial number. For miniature devices only J is added.

Pro Electron System

In Europe, in addition to the standard American JEDEC system a European standard system by the name of Pro Electron is widely used. Designations are assigned by the International Pro Electron Association.

As in the American system, so in this European system the producers register newly produced devices, too. Any producer can produce and trade in devices with an earlier registration designation if the characteristics of the device match those of the already registered device.

Whereas only the number of junctions and the approximate date of production can be determined from the JEDEC markings (since the numbers are assigned in ascending order), the letters and digits used by the Pro Electron system give more information about the device.

The designation under this system is always five-character. Devices intended for wide use, for example home radio and TV receivers, tape recorders etc., are designated by two letters and three digits (for example BC107). Devices for industrial and special apparatus are designated by two letters and two digits (for example BH96).

The first letter designates the material code.

A devices made of material with gap width from 0.6 to 1.0 eV -- germanium;

B devices made of material with gap width from 1.0 to 1.3 eV -- silicon;

C devices made of material with gap width equal to or greater than 1.3 eV -- gallium arsenide;

D devices made of material with gap width less than 0.6 eV -- indium antimonide;

R junctionless devices made of semiconductor material.

The second letter designates the purpose of the device.

A detector fast mixer diode;

B variable-capacitance diode (varicap);

C transistor, low-frequency, low-power;

D transistor, low-frequency, power;

E tunnel diode;

F transistor, high-frequency, low-power;

G complex devices (several different devices in one case);

H magnetic-field strength meter;

K Hall generator;

L transistor, high-frequency, power;

M Hall modulator and multiplier;

P photosensitive devices (photodiodes, phototransistors);

Q radiator;

R device operating in the breakdown region;

S switching low-power transistor;

T regulating and switching devices, power;

X multiplier diode;

Z stabilitron.

If there are several identical devices in one case, marking is done in conformity with the above-indicated code for discrete devices. If there are several different devices in one case, the letter G is used as the second letter of the designation.

For devices of wide use a three-character serial number from 100 to 999 comes after the two letters. For devices intended for use in industrial and special apparatus, the third character is a letter beginning with Z in reverse alphabetical order (Y, X, W etc.), after which comes a serial number from 10 to 99.

A letter showing the difference from the basic type is often added to the basic designation.

For example:

AC180K transistor equivalent to AC180, but in a different case;

BSX51K transistor like BSX51, but higher-voltage etc.

For some types of devices (for example, stabilitrons, power diodes and thyristors) additional classification is possible, according to which a supplemental code is added to the main five-character designation by a dash or as a denominator.

For stabilitrons, for example, the supplementary code contains information about rated voltage and tolerances thereof in percentages:

The first letter designates tolerance: A, 1%; B, 2%; C, 5%; D, 10%; E, 15%.

After the letter in the supplementary code comes rated voltage in volts. If it is not a whole number, then instead of a comma the letter V is placed.

For example: stabilitron BZY-86-C6V8.

This designation gives the following information: special-purpose silicon stabilitron, registration No. Y-83, stabilization voltage 6.8 V, and voltage tolerance $\pm 5\%$.

For rectifier diodes the supplementary code shows the maximum amplitude of the reverse voltage (alternating current).

For thyristors the supplementary code shows the lesser of two values: maximum switching voltage or maximum reverse-voltage amplitude.

For example: BYX-13-200: special-purpose silicon rectifier, registration No. X-13 and voltage 200 V.

At the end of the supplementary code the letter R can be placed, which stands for reversed polarity (anode-case connection).

Normal polarity (cathode-case connection) and symmetric version of leads are not indicated in the code.

For example: BTY-99-100: special-purpose silicon thyristor, registration No. Y99, voltage 100 V, reversed polarity.

The Pro Electron System found wide employment in France, West Germany, Italy and other countries during the 1960's up till now. Prior to it, the old European designation system was used in Europe.

According to it, semiconductor devices were designated by the letter 0 (zero heater voltage according to the accepted code for radio-tube designation).

After the initial letter 0, letters were placed showing the type of device: A, diode; AP, photodiode; AZ, stabilitron; C, transistor; CP, phototransistor; RP, photoconductive cell.

After the letters came the registration number.

For example:

0A81	semiconductor diode with registration No. 81;
0AZ200	stabilitron with registration No. 200;
0C72	transistor with registration No. 72 etc.

Japanese System

From the system now existing in Japan the type of device, its purpose and the type of conductivity can be determined. The material of which the device is made cannot be determined from this system.

The index numbers standing in front of the registration number have the following meanings:

1S semiconductor diode;

2SA PNP transistor, high-frequency;

2SB PNP transistor, low-frequency;

2SC NPN transistor, high-frequency;

2SD NPN transistor, low-frequency;

2SF silicon controlled rectifier;

2SH semiconductor tetrode.

For example: 2SA12 designates a high-frequency PNP transistor with registration No. 12.

English System

In England the military specification is the most popular. Under this system the designation of semiconductor devices consists of two letters CV, followed by a four- or five-digit number.

The British Post Office also produces and issues its own series of devices with the designations P01, P02 etc.

Business-Firm Designations

Besides the systems of standard designations enumerated thus far, some business-firm designations are also widely used in the production of semiconductor devices.

The basis used for the letter designation is the principle of the abbreviated company name, the material code letter and the purpose of the device.

For example: DTG110 is a germanium transistor with the serial No. 110.

D is the initial letter of the Delco Radio Device Company;

T   is transistor;

G   germanium.

The Texas Instruments Company designates its devices with the index number 1G, 1S, 2G, 2S, followed by the registration number. In these symbols the digit 1 designates diode, 2 transistor, the letter G germanium, the letter S silicon.

The Transitron Company uses letter designations for the company and class of device.

TMD50 denotes the following:

T   the company's designation;

MD   microdiode;

50   registration number.

TCR520 denotes the following:

T   the company's designation;

CR   controlled rectifier;

520   registration number.

The Mistral Company uses the letters SF, which are the symbol for semiconductor device. The letter which comes third indicates the class of device:

D   diode;

R   power rectifier diodes;

T   transistors.

For example:

SFD-104 is a video detector diode;

SFR-264 is a rectifier diode;

SFT-353 is a low-frequency transistor.

For marking miniature semiconductor diodes, a color code is often used instead of letter and digit symbols.

Western firms that produce miniature semiconductor diodes use a designation system devised by the U.S. Electronic Industries Association (EIA).

The following designation procedure is adopted under this system:

Digits	Color	Letter
0	Black	--
1	Brown	A
2	Red	B
3	Orange	C
4	Yellow	D
5	Green	E
6	Blue (dove-colored)	F
7	Violet	G
8	Gray	H
9	White	I

When the color code is used to designate diodes, the first digit and the letter N are omitted. The type number coming after the letter N that consists of two, three or four digits is marked with colored rings according to the following rule:

a number consisting of two digits is marked first with a black ring (band) and next a second and third colored band showing the relevant digits. If a letter is used in the designation, it is given as the fourth colored band;

a number consisting of three digits is marked with three colored bands indicating the digits in question. The fourth colored band indicates a letter;

a type number consisting of four digits is marked with four colored bands and a fifth black band. If it is necessary to designate a letter after the digits, it is given with a fifth colored band (instead of a black band).

Two methods are used to designate diode polarity:

the colored bands are placed closer to the cathode;

the first colored band near the cathode is twice as wide.

The type of semiconductor diode is read from the colored bands proceeding from cathode to anode.

6474
CSO: 2202

BULGARIAN WALKIE-TALKIE DESCRIBED

Sofia SERZHANT in Bulgarian No 11, 1977 p 23

[Unattributed article: "Pocket Walkie-Talkies"]

[Text] The RSD-67 FM, RSD-68 FM and RSD-69 FM walkie-talkies produced by the Mikhail Antonov Plant in the city of Gotse Delchev are transistorized transceivers designed to provide two-way simplex communication between moving objects. They meet international requirements for instruments of this type made on the basis of the latest achievements in the field of electronics (integrated hybrid circuits), which in turn helps increase their reliability and reduce their weight and size. The walkie-talkies fit into pressure-cast cases of light material which protect them against the penetration of moisture and dust and shield them from phantom signals. Operation of a maximum of three quartz-stabilized channels is provided. The output power of the transmitter can be adjusted (100÷500 mw) according to the requirements of the customer. Receiver sensitivity is no worse than 0.4 μV. Voice-frequency calling capability is also provided.

The walkie-talkies use a minimum amount of energy (transmitting 120 mA, receiving from 3 to 50 mA). They are powered by a cadmium-nickel battery (ZU-1, ZU-2), which assures operation for eight hours with a reception-to-transmission ratio of 8:1. The battery can be charged more than 200 times.

The walkie-talkies have the following frequency range: RSD-67 FM-A-46÷48 MHz; RSD-67 FM-V-54÷58 MHz; RSD-68-69 FM-A-148÷160 MHz; RSD-68, 69 FM-V-159÷174 MHz.

The output power of the transmitter is from 100 to 500 mw, the input power of the receiver over 200 mw. The modulation is (300÷3000 Hz).

The walkie talkies operate reliably in a temperature range from -25° to $+50^{\circ}$.

Dimensions: 188 x 72 x 34 mm.

Weight: less than 750 grams.

6474
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CZECHOSLOVAKIA

TESTS OF RADIATION EFFECTS ON HUMAN BODY DISCUSSED

Prague ATOM in Czech No 8, 1977 pp 228-229

[Article by Eng Josef Bubenik and Doctor of Natural Sciences Jaromir Jandl: "Phantoms of the Human Body in Dosimetry"]

[Text] Well-known destructive factors accompany the explosion of a nuclear weapon--pressure wave, light radiation, initial and residual ionizing radiation. In spite of the fact that only about 15 percent of the total energy released during a nuclear explosion is consumed for all kinds of ionizing radiation, the radiation is very dangerous from the point of view of its effects on the human organism. The specific characteristic of this radiation as compared to other destructive factors, which can be compared with the effects of classic weapons, is the fact that it cannot be detected by the human senses, and that residual radiation is effective over a long period of time.

Radiation of such composition also occurs when nuclear installations break down. A scientific field called dosimetry of ionizing radiation deals with the problem of determining the presence of ionizing radiation and registration of the effects, particularly in terms of health protection. The scope of activities of dosimetry is very broad. It deals not only with technical problems, but to a great extent also with radiobiological and metrological problems.

Personal dosimetry, considered as part of the overall field of dosimetry, studies problems ranging from measurements of the magnitude of radiation to examinations of damage caused to the human organism in close cooperation with radiobiologists. A suitable measuring element is a personal dosimeter. It retains in itself registered effects of ionizing radiation, which depend among other things on the material of the dosimeter. The alternative ideal would be if the dosimeter were close to the composition of the human body. Then the response of the dosimeter would approximately reflect the extent of damage caused to human organism. However, in most cases a dosimeter is made of other material. That is why dosimeter must also seek a suitable relationship between the data of the dosimeter and the injury caused by radiation to the person who carries the dosimeter.

The determination of this relationship is very complex. During recent studies many factors were discovered which make it more difficult to evaluate the injury caused to the human organism. First of all, it is the type of radiation, its energy, the method of irradiation of the organism, and other factors. On the other hand, the irradiated object affects to some extent the data of dosimetry.

In order to clarify these effects, it is necessary to utilize the results of experimental studies. For understandable reasons, it is not possible to conduct the experiments on human beings. The results obtained by using laboratory animals are very valuable, but they often cannot be applied fully to a human being. An important source consists of basic material obtained during various accidents involving nuclear installations, experiments conducted in uranium mines, and lately from studies of phenomena and consequences of irradiation of astronauts during their stay in space.

However, in order to make new findings, we use in most cases an object which simulates the human organism, namely figurines representing the human body which are called "phantoms."

Types of Phantoms

As a result of the development of computers, and especially of the introduction of a statistical method of modeling (the so-called Monte Carlo method using generators of pseudorandom numbers, which are part of modern typewriters), it would be possible to determine numerically the distribution of doses in various parts of a homogenous anthropomorphous phantom of a cylindrical type, 30 cm. in diameter and 60 cm. high, divided into 150 volumetric elements. In previous recent studies, when the phantom was not built as yet, it was assumed that it would consist principal biogenic elements--hydrogen, carbon, oxygen and nitrogen--in the same ratio as these elements present in a standard person, that is, 6.266×10^{22} (H), 0.994×10^{22} (C), 0.133×10^{22} (N) and 2.549×10^{22} (O) atom of these elements per cubic centimeter. These data were then put in a computer together with data concerning the impact of radiation, and they were evaluated by the Monte Carlo method.

Soviet scientists have built and used a nuclear reactor which measures the distribution of doses of gamma radiation and neutrons on models of phantoms of small dimensions made of polyethylene, polystyrene and graphite.

Many useful results were obtained by using types of phantoms described previously. However, their common disadvantage is that their dimensions are small and that even by their shape they do not correspond to a human body. They are not able to capture the change of distribution of radiation as a result of nonhomogeneity of the body, particularly the influence of bones.

It is generally easy to overcome the first shortcoming by building larger phantoms. Figure 1 shows a phantom made of polyethlene containers, which

by their shape remind one of a human body. Individual containers are filled with water or with the so-called tissue-solution, which corresponds by its properties to human tissue in terms of ionizing radiation.

The most perfect phantom used for accurate measurements and determination of the effects of human body is built in such a way that a human skeleton can be placed in a container made of plastic.

Use of Phantom

The use of phantoms of the human body can be classified basically in three areas:

Research on radiation safety of nuclear installations and reconstruction of their breakdown;

research in the area of personal dosimetry; and

other dosimetric research studies.

In spite of all the safety measures, there are known to have been more than 10 serious accidents involving nuclear reactors (experimental reactors as well as those used in industry) and some other laboratory installations since 1945. Not only did the accidents endanger the service personnel or research workers, but eight persons died as a result of acute diseases caused by irradiation. For example, the accident in the Belgian center for nuclear energy in December 1965 will serve as a sample of the application of a phantom. A worker irradiated by a deadly dose according to data obtained from a film dosimeter, was transported immediately to a special clinic in Paris. The physicians there asked for reconstruction of the accident involving the phantom, which was located at the place where the patient was also present at the critical time. On the basis of data obtained from dosimeters placed not only on the surface but also on the inside of a phantom, in places where important organs are located, they were able to determine the distribution of the dose in the body and the part of the body which was affected most and to apply the corresponding therapy.

Phantoms are often used for preventive gathering of data concerning the radiation field in case of an accident involving, for example, a nuclear reactor. They are placed in the proximity of the reactor (2) and the accident is simulated by making a suitable experimental arrangement. The results obtained from irradiated phantoms are used for computation and construction of the most appropriate screening, for determination of the safest location of the service personnel, and for taking preventive safety measures.

Experiments are conducted at dosimetric and health workplaces, which should provide for maximum level of knowledge applicable in protecting armed forces and civilian population in an emergency situation and for protection of persons who come professionally in contact with ionizing radiation.

Figure 3 shows one of the most advanced phantoms, which is suitable for studies of the effects of external irradiation and for examination of phenomena accompanying internal contamination. By its shape and size, it corresponds to an average human body. It is made of material equivalent to the human skin (from the point of view of radiation absorption). The skeleton of the phantom is made of a real human skeleton. The other parts of the "body," with the exception of the lobes of the lungs, are provided for by a fluid which is equivalent to human tissue, and the lungs are partly aerated. In the center of the body and in places where important functional organs of the human body are located, there are apertures and channels through which measuring sounds or dosimeters can be introduced. The joints of the phantom are mobile, and consequently it is possible to imitate the position of the irradiated object, for example, the position of a sitting worker.

The phantom is used for finding the optimal location of a dosimeter on a human body. Experimental studies are based on two essential ways of irradiation which may take place under conditions existing in the field. The first one is penetrating irradiation from one side, with results from gamma radiation and neutron radiation in a nuclear explosion. The second way is irradiation of the body in a terrain contaminated by radioactive fallout after the explosion. The dosimeter should react in the optimum way to both ways of irradiation, and this must be respected in the preparation of the experiment. When the experiments are evaluated, it is necessary to take into consideration a number of other circumstances. For example, in the case of penetrating radiation, one must consider the broad spectrum of gamma energies and especially energies of neutrons, the fact that they are effective for a very short period of time, and so on. In the case of a contaminated terrain, one must consider a different spectrum of energy, depending on the time allowed from the moment of the explosion, the change of the radiation input as time goes by, and other factors. Another important factor, particularly in dosimetry of neutrons, is also the effect of the proximity of human body to the dosimeter collecting the data.

Dosimeters are placed during irradiation both on the surface of the phantom's body (on the chest, belly, on the side of the thorax, on the back), as well as inside of the body in places which are representative from the point of view of the effects of radiation on the entire body and at places where important organs are located (Figure 4).

Other dosimetric problems are also dealt with by using phantoms. What is of interest is their use for determining the dose of neutrons, for measurements of activity of a radioactive isotope of sodium Na^{24}, which forms in the irradiated organism as a result of nuclear reaction with a nonactive isotope Na^{23}. The "body" of the phantom is filled with a liquid containing the same amount of sodium as it is contained in human organism, and the resulting activity is measured after irradiation by neutrons.

Irradiation of human organism by fast neutrons is also manifested in activation of the hair, in which radioactive isotope of phosphorus P^{32} is formed as a result of nuclear reaction with sulphur, which is present in human

hair. The same reaction takes place, when the irradiated person wears a suit containing wool, because wool is similar to hair in terms of its chemical composition and sulphur content (3-5 percent). That is why phantoms are "dressed" in different types of clothing, and measurements are made of the activity which takes place as a result of irradiation by neutrons (Figure 5).

If one knows what activities take place during the defined irradiation of phantoms, then during the actual irradiation of persons one can detemine the dose of irradiation by neutrons by measuring the activity of the body or the suit.

In these experiments, one gets basic information about the necessary number of diagnostic dosimeters for a correct evaluation of irradiation of the entire body and their most appropriate location, and also basic information about the effects of nonhomogenous methods of irradiation, about irradiation of only part of the body, and so on. On the basis of data obtained from experiments, one can determine criteria for calibration of the dosimetric system in such a way that registration by the dosimeter would be at the optimal level in relation to the damage caused to the organism of the person who has been irradiated.

As a result, the phantoms help effectively to get the knowledge necessary for protection of man against the harmful effects of ionizing radiation.

The phantom shown in figures 3, 4 and 5 is the property of the IHE at the Prague Center for Radiation Hygiene.

Appendix

Figure 1. Phantom made of polyethylene container filled with a solution equivalent to human tissue and ready for measurements (equipped with DK-70 dosimeters).

Figure 2. Experiment for determining the radiation field after an accident involving a nuclear reactor. The phantoms have been placed behind a screen, the properties of which are being tested.

Figure 3. A more advanced types of phantom with a human skeleton and a "body" made of plastic.

Figure 4. A view of the phantom with dosimeters during irradiation by isotope of cobalt Co^{60}.

Figure 5. Arrangement of an experiment involving a dressed phantom.

5668
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KARLSBURG DIABETES CENTER DESCRIBED

East Berlin URANIA in German Vol 53 No 10, Oct 77 signed to press 23 Aug 77 pp 65-67

[Article by Prof Dr H. Bibergeil and P. Wulfert, chemist: "Karlsburg: GDR Center for Control of Diabetes"]

[Text] Ivan Matveyevich Yesin, professor of pedagogical scientists, who as a guards major in the Red Army in the Soviet military administration during the first days of reconstruction was partially responsible for the reopening of the universities of Rostock and Greifswald, recalls, "...Professor Katsch, one of the men who saved Greifswald from destruction, asked for land for a diabetes institute. He wanted a document. I could not give him one. But I advised him, 'Find yourself a nice piece of ground, convert the manor house into an institute building, paint it all white, if you have to, so that it will look scientific, and once you have patients there, a lawyer will turn up to fill in the legal technicalities for us.' When I came back to Greifswald in 1958, I could hardly find the old castle we had rigged out in those days, such big buildings had sprung up around it!"

That is how the foundations were laid back in the first days of our socialist state which permit us today to deal effectively with a social medical problem as great as that of sugar diabetes. The first steps in this direction were taken even earlier. Nearly 50 years ago the director of the Greifswald University Medical Clinic, Prof Dr Gerhardt Katsch (1887-1961) developed, ahead of his time, the basic principles of "productive treatment of diabetes" and attempted their practical application in a former reformatory in Garz auf Rügen. His aim -- medical and social rehabilitation of the chronic diabetic, with maintenance of his capacity to work -- has been realized not only in one institution but throughout our republic by outpatient treatment of diabetics. We say the diabetic can be "conditionally healthy."

In accordance with the demands made by our socialist society on public health institutions for the well-being of each individual patient and under the particular efforts of Prof Dr Gerhard Mohnike (1918 to 1966) and his colleagues in the 1950's and 1960's, the building complex of today's Gerhardt Katsch Central Institute for Diabetes grew up around the baroque castle. It

is situated on Highway 109 between Greifswald and Anklam and employs more than 500 workers, including nearly 70 doctors and scientists.

What is Diabetes?

Diabetes mellitus -- sugar diabetes -- is a chronic metabolic ailment. It occurs relatively often in countries with a high standard of living. There are now 480,000 known diabetics under continuous treatment in the GDR, and planned mass examinations lead to early diagnosis of previously unknown diabetics, so that we can expect about a million diabetics in the GDR in the near future.

Diabetes is not a single disease (see color chart, p 64). Two main types of diabetes are distinguished: juvenile diabetes and adult or senile diabetes. The former occurs primarily (but not always) in children, youths, and young adults, and as a rule develops quickly in a few days or weeks. Adult diabetes develops primarily in the later years of life and often develops very slowly, over months or years, usually unnoticed by the patient.

Central to both types of diabetes mellitus is the pancreas, or, to be more precise, the islands of Langerhans, which are found in this organ of the upper part of the abdomen. Insulin, the only hormone of the organism that attacks blood sugar, is formed in what are called the B cells of the islands of Langerhans. If this is lacking (as it is in juvenile diabetes except in the initial stages) or if it is insufficiently effective (as in adult diabetes), then the glucose metabolism is disturbed, especially in the most important organs of the intermediate metabolism and energy production, such as the liver, the musculature, and the fatty tissues.

It must be assumed that a basic genetic disturbance, the nature of which is not adequately understood, is the cause of both types of diabetes. For some of the juvenile type there is some discussion of the possibility of a virus infection in conjunction with immunological processes. At present nothing conclusive can be said about this hypothesis.

Besides endogenous factors, environmental factors are always associated with the development of diabetes mellitus. This applies particularly to adult diabetes. The most outstanding of these factors are overeating and improper diet, disturbances in the fat metabolism (hyperlipoproteinemia), poorly conditioned musculature, and psychoneurotic influences (stress). First, these environmental factors cause changes in the glucose-utilizing organs (fatty liver, inactivation of the musculature, and hypertrophy of the adipose tissue), which restrict the effectiveness of insulin; recently a decrease in the insulin receptors on the membrane of the adipose cells has been established. Second, these environmental factors favor the development of disorders of the arterial vessels (macroangiopathy), either directly or indirectly through the diabetic metabolic disturbance. In these cases there is a close association and interaction of several frequent disorders, so that we speak of a "metabolic syndrome." The result of a long-term restriction of the effectiveness of insulin may be an exhaustion -- due to overexertion -- of the B cells in the islands of

Langerhans in the pancreas and consequently of the formation and secretion of insulin (to the extent that a basic genetic defect is present).

Besides a disturbance of the glucose metabolism and its hormonal causes, the pathology of diabetes also includes complications in the circulatory system. The macroangiopathy mentioned corresponds to an early and usually progressively developing arteriosclerosis. This arteriosclerosis is predominantly connected with the adult type of diabetes mellitus, and may appear in advance of, parallel to, or following the diabetes. The macroangiopathy taking place in the small vessels, especially those of the retina of the eye and of the kidneys, is primarily considered a result of insulin deficiency and disturbed metabolism.

Herein lie the real risks of the disease, now that the mortally dangerous diabetic coma has become infrequent because of continuous medical treatment of diabetics. Even now, with the best of social medical care, these risks can only be more or less diminished, not always avoided.

Catalog of Missions of the Karlsburg Institute

In spite of worldwide research, many problems connected with the origin and treatment of diabetes are still unexplained. The scientific tasks that face the Central Institute in Karlsburg include contributions in close collaboration with the USSR to the development of a therapeutically usable "artificial B cell," -- a release of insulin, controlled by the current blood sugar level, from a system that can be partially or entirely implanted (incorrectly termed the "artificial pancreas"). This future possibility of treatment, which is now still in the research stage, may actually eliminate the risks in the case of certain diabetics who are in need of insulin and may also produce new knowledge of the clinical picture of the disease. But the spectrum of research tasks extends beyond that. They also include the use of the artificial kidney to deal with aftereffects involving the kidneys, as well as research to clarify the pathological mechanisms sketched above. But most especially, the institute is to devote itself to questions of prophylaxis, early recognition, and possibilities of delaying the real attack, the manifestation of the disease. These questions constitute an essential part of the tasks of the research project "Diabetes Mellitus and Disorders of the Fat Metabolism," which the central institute is assigned to direct. Study groups from 16 scientific institutes in the GDR are involved in this project.

A high-priority clinical problem is the care of the pregnant diabetic. In the pre-insulin era diabetes during pregnancy was a death sentence for the expected child and often for the mother as well; 20 years ago it involved an infant mortality of 20 percent; today, without especially great risk to the mother, 95 percent of the children expected at the Karlsburg obstetric and gynecological clinic are born alive and saved. This success has occasioned the establishment of four additional obstetrical centers within the GDR, with a resulting optimal care of pregnant diabetics.

Theoretical research and practical advanced training are multilayered tasks of the institute. They range from the training of the diabetics themselves

to the systematic advanced training, which is highly esteemed even internationally, of the medical personnel who care for them. The central institute bears the responsibility for the direction and constant improvement of the control of diabetes. This important task is being carried out with support from the work of the medical staffs of the dispensaries of the outpatient clinics of the kreises and bezirks of the GDR and of the Center for Diabetes in Berlin and in close collaboration with them. The family doctor, who is obviously involved in the basic care of the diabetic patient, also bears a heavy responsibility.

It is not only to the diabetics of the GDR that Karlsburg is a special concept; it also enjoys a good reputation internationally. The central institute follows the tradition of its founder, Prof Katsch, and at the same time it develops new, modern research fields. It functions as a coordinating institution for multilateral collaboration of the socialist countries in the field of endocrine diseases, especially diabetes. This has certainly been furthered by the fact that leading experts on diabetes in the People's Republic of Bulgaria, the CSSR, and Poland worked in Karlsburg while getting their specialized training as clinicians and researchers, and that numerous Karlsburg workers have given lecture series in all of the friendly socialist countries and even other states. This international esteem is confirmed by nine "Karlsburg Symposia on Diabetes Problems," at each of which leading scientists from about 15 countries of the world were present.

Even at the first symposium Soviet scientists were our guests. They have always made scientific contributions of the first rank, and we have supplemented and do supplement each other in friendly and fruitful collaboration, which really began with Prof Yesin's "requisitioning" the castle. Mutual visits for meetings have long since developed into working tours. Such a visit by Prof Baranov to Karlsburg in 1972, for example, was the last step before the concluding of a contract for coöperation with the Institute for Gynecology and Obstetrics (endocrinological department) and the I.P. Pavlov Institute for Physiology in Leningrad. The next connections were made with Prof Yefimov of the Institute for Endocrinology and Metabolic Disorders in Kiev and with Prof Yudayev of the Institute for Experimental Endocrinology in Moscow. The circle of research subjects worked upon jointly with Soviet scientists was finally completed in 1976 with the concluding of a contract with Prof Zhumakov and his colleagues at the Institure for Transplantation and Artificial Organs at Moscow, -- a circle of cooperation of friends for the common good.

5588
CSO: 2302

PROBLEMS, PROSPECTS IN CONTROLLED NUCLEAR FUSION DISCUSSED

East Berlin SPEKTRUM in German Vol 8 No 9, Sep 77, pp 12-15

[Article by Karl-Friedrich Alexander, member, GDR Academy of Sciences and Prof Dr Karl-Heinze Krebs]

[Text] In order to assure the long-range energy supply for society while simultaneously preserving the environment, controlled nuclear fusion must be employed as a future energy source. Thus Professor M. S. Rabinovich, one of the leading Soviet researchers in this field, said at last year's meeting of the GDR Physics Society that "no country can ignore this path, so it seems to me, and avoid participating in working out the problem of controlled nuclear fusion." Indeed the progress of the industrial nations participating in fusion research--foremost of which are the USSR, the United States, and Japan,and the countries associated with the West European atomic community--is so encouraging that the 13th ICPIG in the GDR capital ought to be an occasion for a few observations about controlled thermonuclear fusion and its utilization as an energy source.

Physical Basics

Recall that binding energy is released not only by the heavy nuclei standing at the end of the periodic system but also by the coalescence (fusion) of a light nucleus with a heavier one. This is represented schematically in Figure 1.

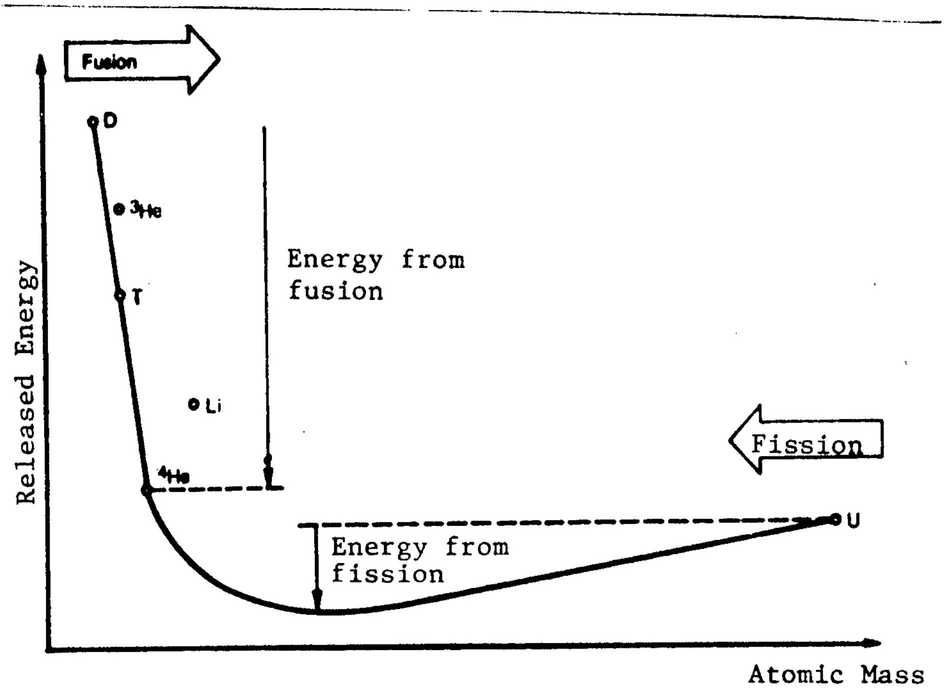
Of the fusion reactions which come into consideration, the most advantageous is that between the heavy hydrogen isotopes of deuterium and tritium:

$$D + T \rightarrow {}^{4}He\ (3.52\ Mev) + n\ (14.06\ Mev)$$

While the required deuterium is present in water in adquate amounts, tritium must be artifically produced. This can be accomplished by the absorption of the fusion neutrons in lithium:

$$^{6}Li + n \rightarrow {}^{4}He + T + 4.78\ Mev$$

Figure 1. Schematic Representation of the Release of Nuclear Binding Energy



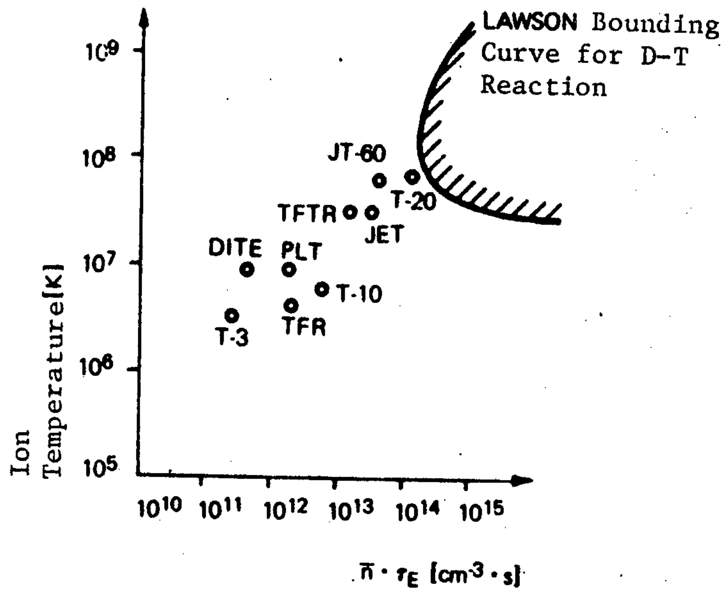
The total energy gain of this reaction cycle amounts to 2300 megawatt-days per kg of fuel, D + T + ^{6}Li, introduced, which is more than double the amount of energy released by the complete fissioning of 1 kg of uranium. In contrast to uranium fission, no radioactive end products (atomic waste) arise from fusion. Estimates have shown that the lithium supply on the earth, even in the case of enormously increasing energy use, will suffice for more than 10,000 years. Presently the basic problem in a fusion reactor is to achieve fusion reactions at all and with sufficient frequency. In order for two nuclei to be able to fuse, their electrostatic repulsion forces must be overcome. This can happen with sufficiently high temperature ($T > 10^{8}$K). In order to obtain such reactions sufficiently often, as many as possible ionized particles (plasma) must be held together for an adequate time. Expressed in terms of physical quantities this means that the product of the particle density n and the confinement time τ must be sufficiently large. With these two requirements the minimum conditions for an energy release by means of fusion can be formulated:

1) generating a temperature $> 10^{8}$K

2) reaching a value of the product of density and containment time $n\tau > 10^{20} m^{-3} s$.

This Lawson criterion specifies the conditions which must be fulfilled in order that the fusion reaction in the plasma ignites, in other words, can sustain itself. To heat a plasma with 10^{20} atoms per cubic meter (this is a typical value) to the ignition temperature requires, ignoring losses, about one kilowatt-hours per cubic meter. The minimum values corresponding to the Lawson criterion are plotted in Figure 2 as a bounding curve. Simultaneously, the values reached to date by some of the more important experimental facilities are indicated in order to demonstrate the development of the last few years.

Figure 2. Some of the Existing and Planned Tokamak Facilities in the Lawson Diagram. (T-20 USSR, JT-60 Japan, JET Euratom, TFTR USA, PLT USA, T-10 USSR, DITE England, TFR France)



The hot reaction plasma, which, because of its high internal pressure is anxious to expand quickly outward, must be held together for a sufficiently long time and prevented from coming in contact with the walls of the reaction vessel, since it would then immediately be cooled again. That can be achieved with the help of strong magnetic fields (magnetic confinement) or also by the principle of so-called inertial confinement.

In magnetic confinement the magnetic field must serve three functions. It must first of all compensate the internal pressure of the plasma and prevent it from flying apart. Second, it must suppress plasma instabilities, for example, deformations and oscillations, and third, it must reduce the heat conductivity of the plasma to an extent that, with the help of an external energy source, the plasma can be heated to the ignition temperature and then "burn" with energy release.

From the third requirement it follows that the plasma volume at the very minimum must have a definite critical size, since the energy loss through heat conduction depends on the surface to volume ratio and on the magnitude of the temperature gradient.

Of the different methods of magnetic confinement, the Tokamak system, which was first developed in the USSR, is presently the world-wide favorite (photo, p. 12) [not included] (tok - current; kamera - chamber; magnitniye katushki - magnet coil). The main component of a tokamak is a torus in which the basic magnetic field (torroidal magnetic field) is produced through external coils. This magnetic field primarily fulfills the above-mentioned second and third functions. The compensation of the plasma pressure is achieved by means of a magnetic field produced in conjunction with an induced high current flowing in the plasma ring (poloidal magnetic field). This current, which simultaneously causes an ohmic heating of the plasma, is induced through a transformer in which the plasma ring acts as the "secondary coil."

Inertial confinement is, in principle, simpler, but as yet realized technically only in the relatively simple way represented by the hydrogen bomb. In this case the Lawson criterion is fulfilled by considering that with a very high plasma density the confinement time τ can be chosen very small. Then the mass inertia of the reaction material suffices, so that before separation, a sufficient portion undergoes fusion reactions. The problem here consists of feeding into the very small reaction volume the required amount of energy to reach the ignition temperature in the very short time of a few nanoseconds. To achieve this, instantaneous powers of the order of terawatts are required. One hopes to reach this goal by focusing intensive laser or electron beams onto a small sphere made from a mixture of deuterium and tritium (see Figure and photo on p 13)[not included].

Present Problems

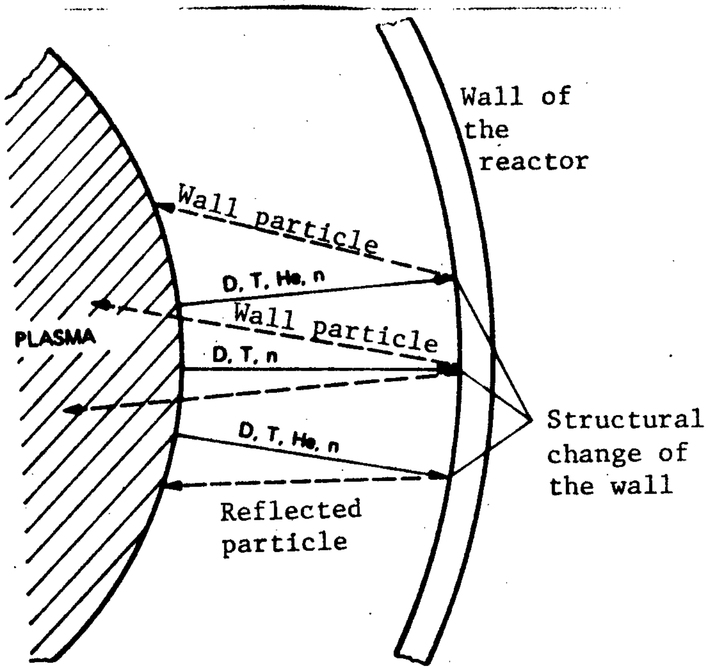
The values indicated in Figure 2 show the presently attained results. We now ask--limiting ourselves to the favored Tokamak geometry--which problems must be solved in the next years so that the large facilities planned can work in the region of the Lawson bounding curve.

The necessary geometric enlargement of the facilities results from the above-mentioned demand for attaining the critical sizes of the plasma volume for the chosen arrangement. For the Tokamak they lie probably at a few hundred cubic meters.

The ohmic (resistance) heating does not suffice to reach the required temperatures because the plasma resistance decreases strongly with increasing temperature while the radiation loss grows. Consequently, one of the main problems is the development and testing of mechanisms for additional heating. Besides the so-called "adiabatic compression," by which compression and additional heating of the plasma is attained through a sudden increase of the magnetic field, neutral particle injection and high frequency heating are being investigated as heating mechanisms. The technical problems of the neutral particle injection are being intensively addressed. At a source, an intense current beam of deuterium ions is produced. These ions are neutralized in an associated charge-exchange chamber so that they can pass through the magnetic field without deflection and penetrate into the plasma. There they are again ionized, giving up their kinetic energy through collisions with the particles of the plasma, thereby warming the latter. For the machine succeeding the T-10, the presently projected T-10M, a total of 5 MW heating power from a neutral beam injection generator is anticipated. In the case of high frequency heating, a high frequency current is induced in the plasma by means of external coils or wave guides. The frequency is chosen to match the plasma resonances, resulting in high energy absorption and consequently considerable heating (see photo, p 15) [not included].

Impurities in the plasma especially those with high atomic number Z, constitute a special problem to reaching the necessary temperature. These arise through effects of the so-called "plasma-wall exchange" (Figure 3). Atomic particles and neutrons from the plasma discharge collide with considerable

Figure 3. Scheme for the Plasma-wall Exchange



kinetic energy on the inner surface of the torus wall, which is made from a high melting temperature material. These collisions result in the atomization of the wall material with accompanying structural changes, and the wall material ends up in the plasma. As a consequence of the wall impurity ionization, a high radiation loss through brems-strahlung, which increases quadratically with the atomic number, arises. The investigation of the effects of the plasma-wall exchange, as well as development of methods to reduce the impurity concentration in the plasma, constitute a further main area of work of present fusion research which members of the ZIE of the AdW are participating in.

Further physical-technical problems which must be resolved in order to construct the next generations of research facilities up to and including a demonstration fusion power plant are only enumerated:

The technical achievement of large volume strong magnetic fields with super-conducting coils (the T-10M is to be equipped with superconducting magnets);

The physics and chemistry of the fuel cycle and the construction of the breeding blanket in which the tritium is produced and the largest portion of the useful energy as heat is released;

General material problems (radiation dose, high temperatures, superconductors, high vacuum).

It is characteristic of the present situation that the emphasis of fusion research is moving strongly away from pure plasma physics investigations and towards the interdisciplinary solution of such complex technical problems. For example, in June of this year in Leningrad, an all-union conference addressing itself to the engineering-technological problems took place.

Further Prospects

It is generally assumed that after the solution of the problems mentioned, pure fusion conditions will be reached in the planned large research facilities denoted in Figure 2 in the second half of the '80's. The task then will be to develop experimental power reactors, so that perhaps around the turn of the century the first controlled fusion demonstration power plant can be placed in operation.

The advantages of the fusion reactors, as opposed to those operating on the fission principle, over and above the fact that the fuel reserves will suffice for thousands of years, lie principally in their high safety aspects:

The only volatile radionuclide that occurs is tritium. It has, in contrast to the plutonium and fission products of the fission reactor, a significantly smaller toxicity; besides, the total inventory only amounts to a few kilograms.

In fusion reactors a catastrophic power excursion cannot occur, that means it cannot go out of control. The so-called "after heat" power production, possibly accompanying a loss of cooling, is under one percent of the reactor thermal power level.

A fusion reactor possesses a closed internal fuel cycle. There does not exist the necessity for the continuous transport of radioactive materials, for instance, to a reprocessing facility. The problem of storing radioactive wastes doesn't exist. Only the activated components surrounding the reactor, which must be replaced after long operation times and which contain a few long-lived radionuclides, must, of course, be safely stored.

Fusion reactors should not be viewed exclusively as competition to the fission reactors. If fusion technically matures by the beginning of the next century, there will already be a highly developed nuclear energy economy based on the thermal reactors and increasingly on fast breeder reactors. It is entirely possible that the contribution of fusion to the nuclear energy economy of the future will go through a preliminary phase in which the fusion neutrons are used to breed plutonium in a so-called hybrid reactor. For it is entirely questionable whether or not the breeding rate of the fast reactors will suffice to meet the fast growth rate of energy production on the basis of fission alone. The Leningrad conference addressed this aspect with particular emphasis.

Control of nuclear fusion is one of the greatest challenges to scientists and engineers--to develop in a controlled way what has been taking place for millions of years within the stars.

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DATA ON NEW ROMANIAN PARADONTOLOGICAL PROCEDURE

Bucharest FLACARA in Romanian 17 Nov 77 p 11

[Interview with Dr Tudorache Enache, director of the Vrancea County Health Directorate, and Dr Alexandru Dan Taban, by N. Grigore Marasanu]

[Text] In several of its issues, FLACARA has brought to the public's attention new aspects of the Romanian method for combatting paradontopathies, a method which is unique in the world and which was initiated, founded, and practiced with resounding success by the Romanian doctor Grigore Osipov-Sinesti. Using this method, the doctor has treated and cured thousands of patients. The interest which it has stirred and continues to stir here and abroad, at medical centers in Turin, Rome, Madrid, Grenoble, Hamburg, and elsewhere, proves its value and effectiveness in treating and curing paradontopathies. The Paradontology Center of the Bucur Hospital in Bucharest has recently awarded certificates to eight stomatology doctors from several counties, who have followed an intensive two-month course under the guidance of Dr Osipov-Stinesti; these certificates entitle them to practice the operating methods of the Romanian specialist. To what extent is this method being used?

In Focsani, we spoke to Dr Tudorache Enache, director of the Vrancea County Health Directorate. "We have sent a stomatologist for specialization," he said, "wanting very much not to miss an occasion offered to us, of applying in our young county a new Romanian method of treatment, verified and prized throughout the world. It would be unfair if this method were to be used successfully in other countries, while our people, among whom it was created, do not derive its benefits. Skeptics who argue against new ideas without even knowing what they are about, are found everywhere. Some do it because it is easy, others because they are ignorant, and still others (and here the situation becomes serious) intentionally."

[Question] Comrade director, when and where will the new paradontology office be opened in Focsani?

[Answer] Two available rooms of the County Stomatologic Center have already been outfitted for the new paradontology office. We have located it here as a new operation method, which at this beginning stage is being practiced only by Dr Alexandru Dan Taban, so that the operation will be performed amidst or in the immediate vicinity of all stomatologists, in order to convince as many of them as possible and gain new converts. At the same time, we sought to use all the services of the stomatologic center, such as sterilization facilities, radiology installations, dental technology shops, and so on.

Doctor Alexandru Dan Taban, an eager young man and an enthusiastic supporter of the new method, received his specialized training from Dr Grigore Osipov-Sinesti himself, as have his other seven colleagues in Romania; it was he who operated on the first three patients. It is true that he operated on them in Bucharest, but that is because the Focsani office was still being completed. Now he cares for them here in Focsani. We spoke to all three patients, only one day after the operation. They feel well and are extremely glad that such a medical facility could be also provided in Focsani, through the concern of local party organs, and through the interest of the County Health Directorate and its open-mindedness to new ideas.

[Question] Dr Taban, what is your sincere opinion about the new operation method?

[Answer] Foreign specialists qualify Dr Grigore Osipov-Sinesti's method as revolutionary. The famous Italian professor, Franco Noveri, of the Turin Odontology Institute, has said that the Romanian doctor "is the first specialists who has taken paradontology from the hands of a simple dentist, and has raised it to the level of a medico-surgical discipline." I personally support the method and work of Dr Osipov-Sinesti, and I will always practice it will all my conviction. In our activity in the new Paradontology Office in Focsani, we hope to prove that this new Romanian method is worthy of its name. In Bucharest we have seen people who were operated on by the author of this method 20 years ago; they have told us, and we observed it for ourselves, that they were in excellent health. Is this not the most eloquent argument for those who for one reason or another still do not accept this method?

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